NewSpace:

The Emerging Commercial Space Industry

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LEARNING OUTCOMES

At the end of this lecture you should be able to:

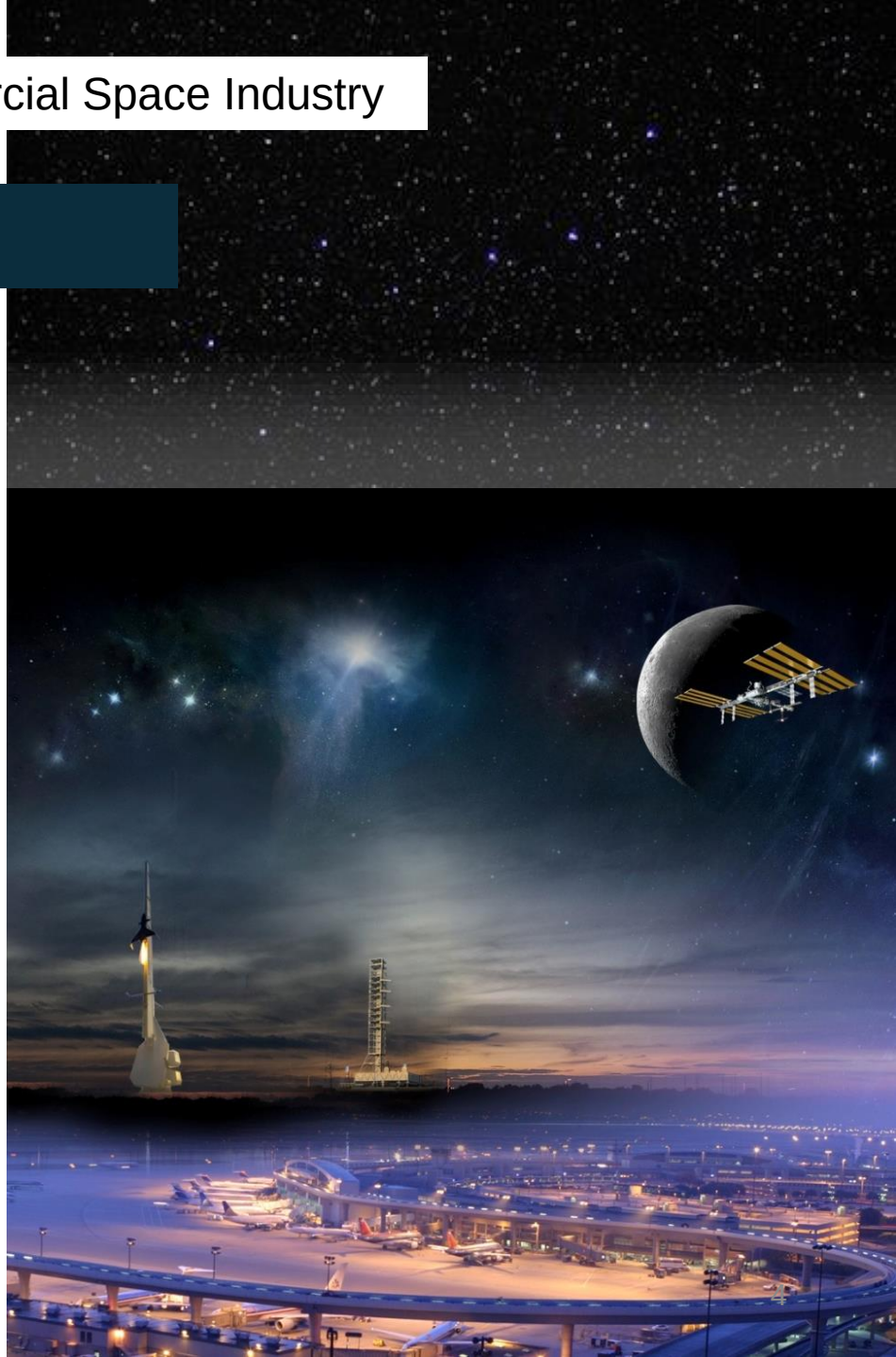
1) Describe the areas in which entrepreneurial companies are developing new markets
2) Name a few companies that are examples of the commercial space revolution
3) Discuss how governments and private investments can facilitate the birth of this new industry

WHY IS THIS LECTURE IMPORTANT?

- We are at a turning point in the history of space exploration and development – the cusp of a revolution, new industries are being born that use space in many non-traditional ways
- The established state run industrial space sector is no longer the only game in town
- Increased competition and new capabilities will change the space frontier forever
- Everyone interested in working in the space sector will be effected

OUTLINE

1. Regimes for NewSpace Opportunities
   - Suborbital
   - Orbital
   - Deep Space
2. Example NewSpace Companies
3. The Role of Government
4. The Role of Private Industry



WHAT IS NEWSPACE?

From Wikipedia:

*"**NewSpace**—formerly **alt.space**; also "**new space**,"[1][2] **entrepreneurial space**, and "**commercial space**"[3][4][5][6]—are umbrella terms for a movement and philosophy[7] encompassing, but substantially broader than, an emergent, somewhat more visible and defined, private spaceflight industry. Specifically, the terms are used to refer to a community of relatively new aerospace companies working to independently (of governments and their prime/major contractors, i.e., Old Space) develop faster, better, and cheaper access to space, space and spaceflight technologies, and space missions, as a threshold matter; and designers and advocates of such underlying space and spaceflight concepts, architectures, systems, technologies, missions, programs, protocols, and policies."*

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Regimes for NewSpace Opportunities

SUBORBITAL

Description:

- Spacecraft reaches space 100 km (62 miles) or higher but does not have the forward velocity to go into orbit (e.g. 7.7km/s at 300 km)

Tourist Industry:

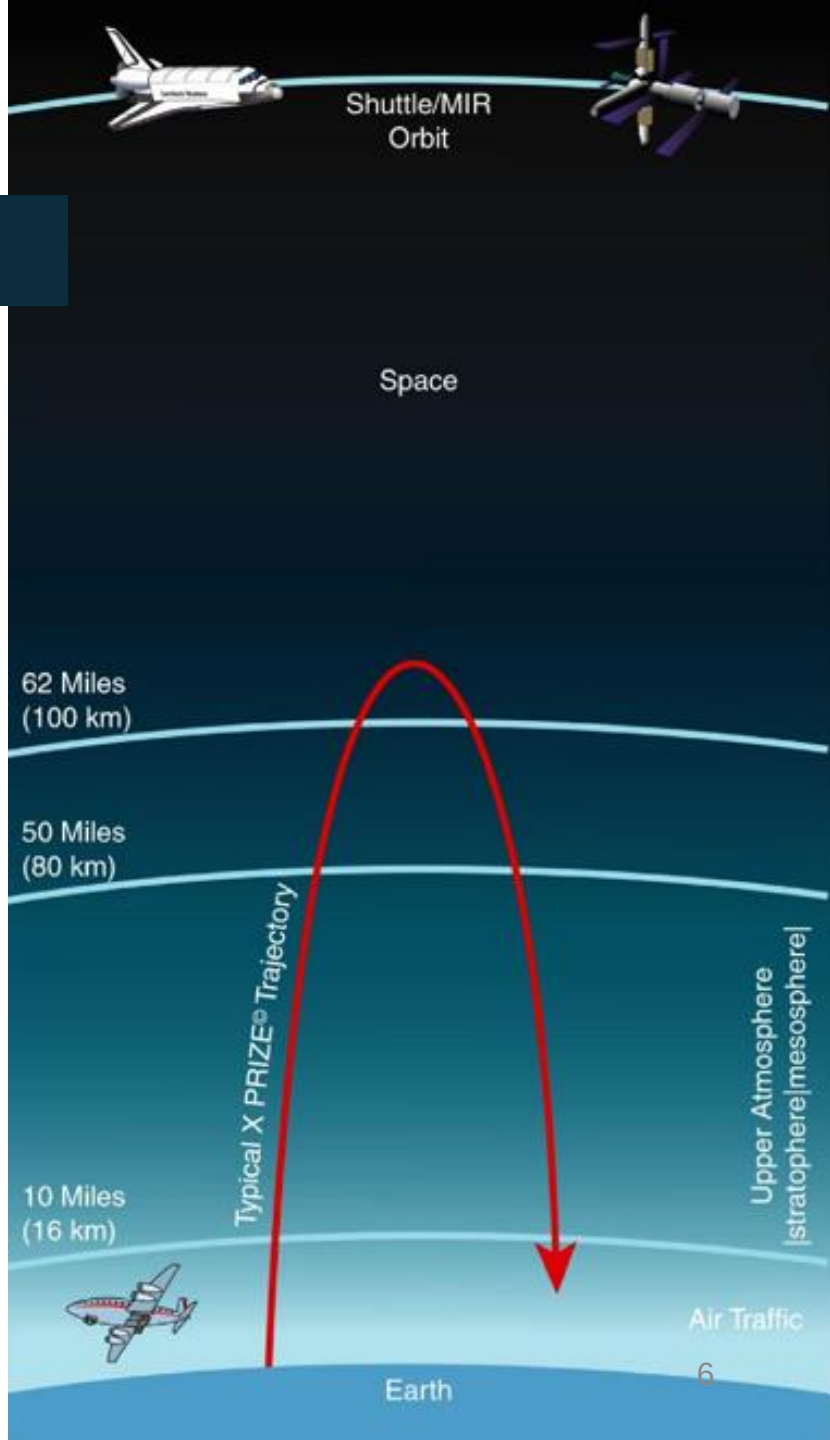
- Companies selling tickets for the suborbital experience from $250K (Virgin Galactic) to $150K (XCOR) per seat

Research:

- Microgravity (around 4 minutes)
- Upper atmospheric measurements
- Technology demonstrations
- Life Science experiments

Point-to-Point Travel:

- Travel from one location on Earth to another through space
- Challenging technical problems
- Long-term goal not a current focus



Regimes for NewSpace Opportunities

ORBITAL

Description:

- Low Earth Orbit (LEO) 180 – 3000km
- High Earth Orbit (HEO) – Geocentric 35,786km

Tourist Industry:

- Provides long periods of time in microgravity at ISS or on private space stations
- Space Adventures: 7 private citizens to ISS (8 missions – $20M-$52M per trip)

Research/Applications:

- Conduct experiments continuously in the orbital environment (microgravity and life sciences)
- Produce commercial products
- Launch small spacecraft from ISS

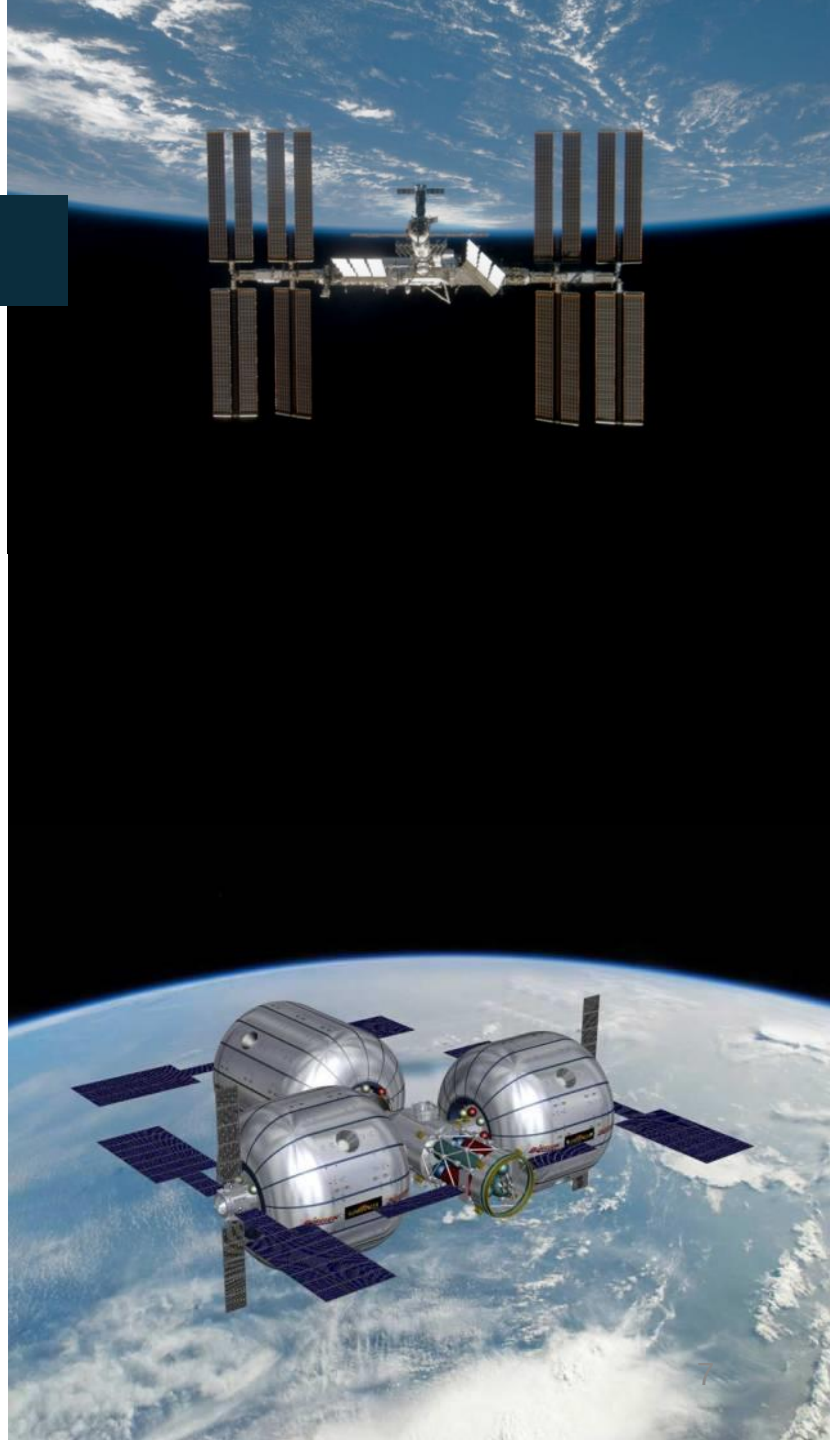
Satellite Servicing:

- Service satellites, put them in proper orbits, refuel, fix and upgrade systems

Earth Imaging:

- Natural resources, site development, crop monitoring, asset management…

Broadband:



Regimes for NewSpace Opportunities

DEEP SPACE

Description:
- Lagrange points, Moon, Asteroids, Mars and beyond

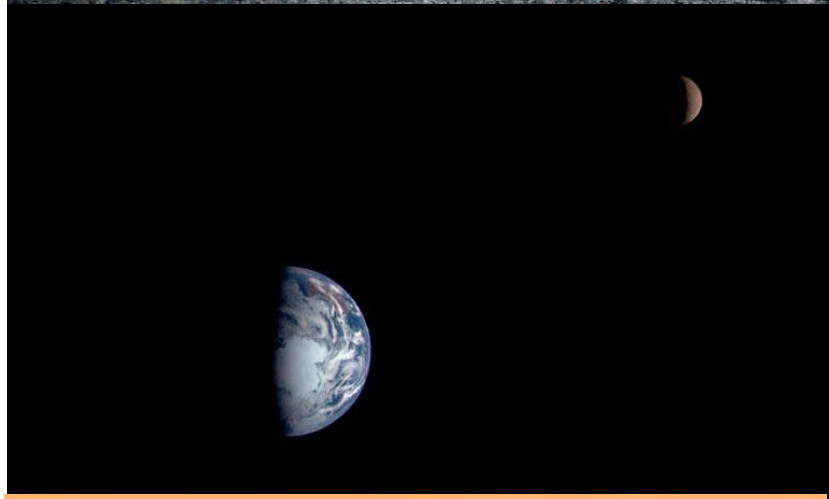
Tourist Industry:
- Ultimate in exotic experiences, Lunar and Mars

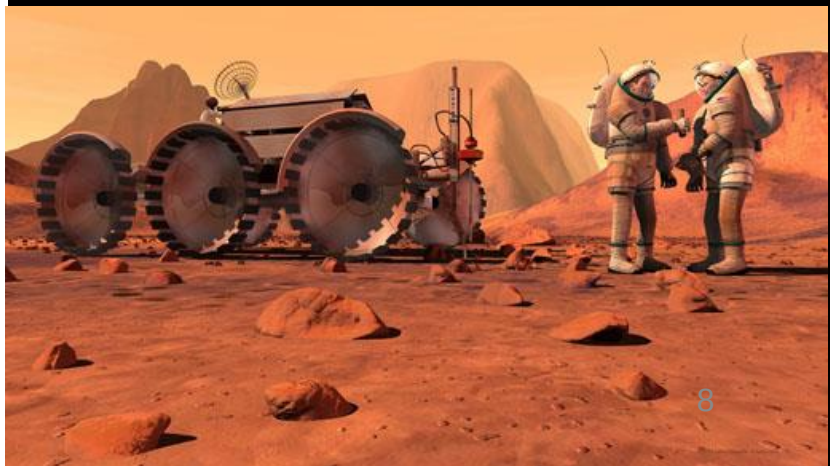
Research:
- Enabling Humans to be productive and happy in space; in-space economy
- Developing new materials and processes to create new markets and improve life

Mining and In Situ Resource Utilization:
- Examples: Propellants, metal & materials processing, and building materials

Servicing a space-based economy:
- Examples: 3D printing in space, space manufacturing

Settlement:
- Moving human civilization to Moon and Mars





Examples of NewSpace Companies

SUBORBITAL, ORBITAL

HQ: Las Cruces, New Mexico

Founded: 2004 Richard Branson (Virgin Group)

Focus: Space Tourism & Research; Low-cost small satellite launch

Cost: $250K per seat, $10M per satellite

Major Partnerships: Spaceport America in New Mexico, Y3, and, Landrover

Examples of NewSpace Companies

SUBORBITAL and ORBITAL

NANORACKS

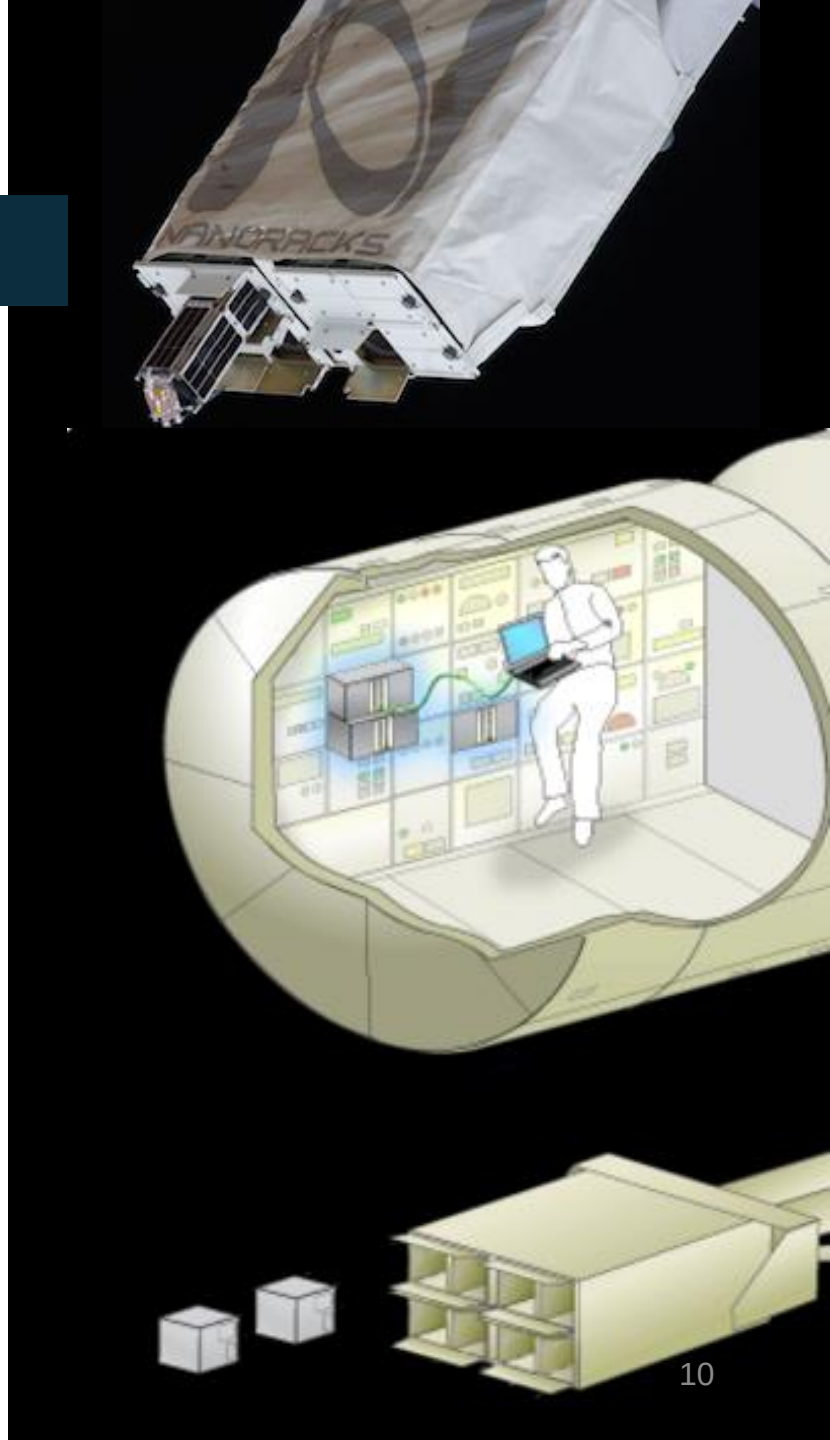
HQ: Houston, TX

Founded: 2009 CEO Jeff Manber (MirCorp)

Focus: Sub-orbital (Blue Origins); On-orbit (and beyond) research and smallsat launch, ISS internal and external, and beyond

Cost: Variable based on hardware and services needed. Internal educational payloads start at $15K, deployment starts at $85,000 (1U CubeSat)

Major Partnerships: XCOR, Astrium, Schafer, Spaceflight Services, Ardulab, GOMspace, and Student S/F Exp. Program



Examples of NewSpace Companies

ORBITAL

planet.

See Change.
Change the World.

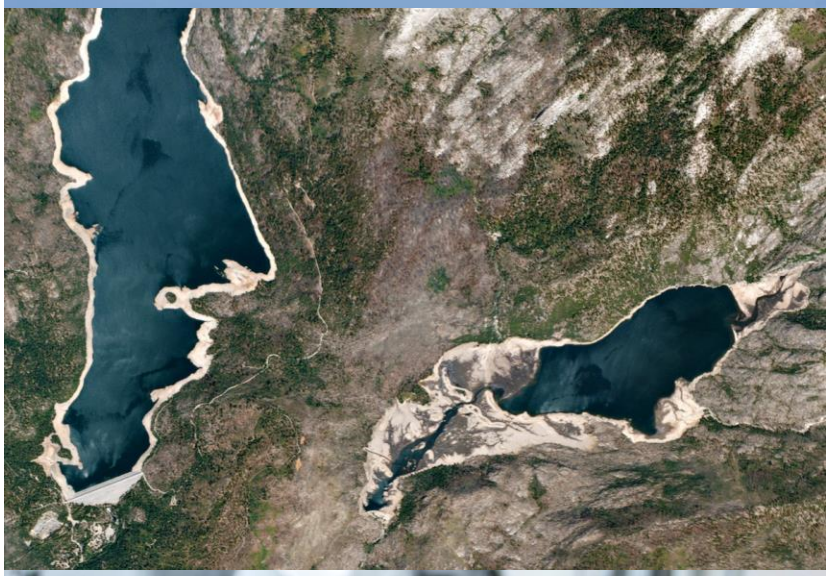
HQ: San Francisco, California

Founded: 2010 Will Marshall, Robbie Schingler, Chris Boshuizen

Focus: Applications, Earth Sensing

Capacity: Launched over 179 smallsats, resolution (145 made it to orbit); 10 square feet resolution

Major Partnerships: Raised $183M in 5 years



Examples of NewSpace Companies

ORBITAL

HQ: North Las Vegas, NV

Founded: 1998 by Robert Bigelow

Focus: Orbital stations

Capacity: BEAM 16m^3 on ISS; BA330 has 330m^3 of internal space

Cost: $25M for 110$m^3$ for 60 days (1/3 of BA330

Major Partnerships: NASA, SpaceX, Boeing, ULA

Examples of NewSpace Companies

ORBITAL, DEEP SPACE

SPACEX

HQ: Hawthorne, California

Founded: 2002 Elon Musk

Focus: Reusable transport to Low Earth Orbit (ISS), Geostationary Transfer Orbit (GTO), Mars

Cost: $62M Falcon 9 Full Thrust; Falcon Heavy $90M for 8mt to GTO

Major Partnerships: NASA Commercial Crew

Examples of NewSpace Companies

DEEP SPACE

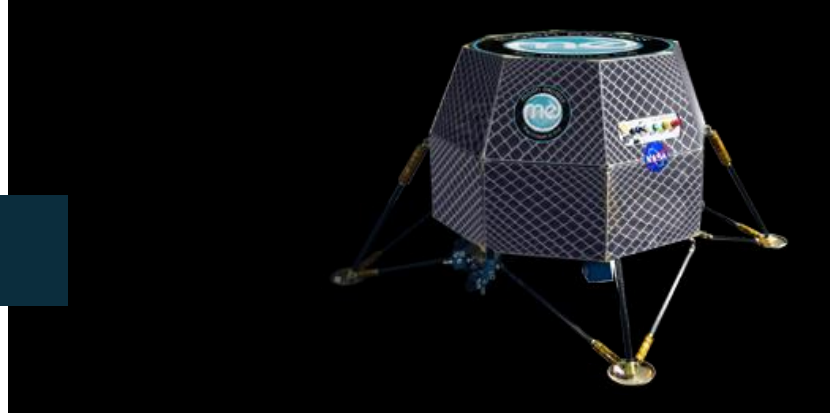
HQ: Moved to NASA KSC, Florida

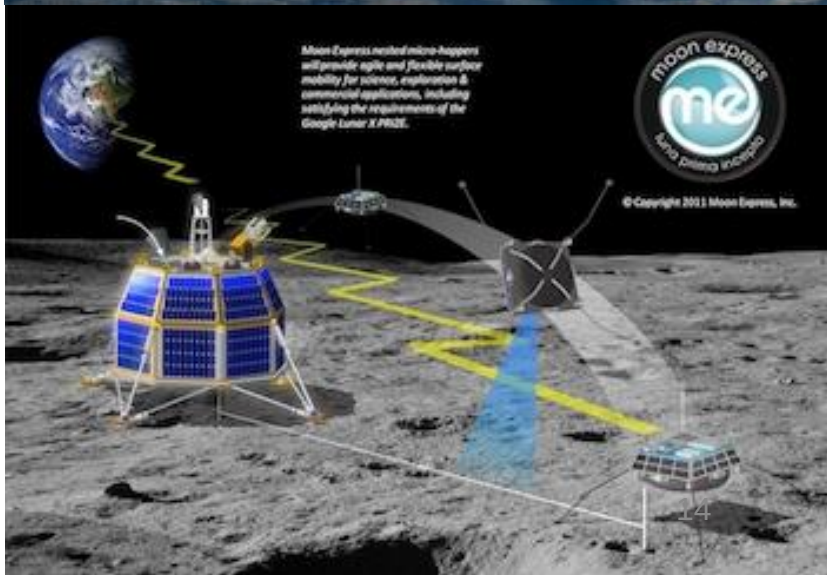
Founded: 2010 Bob Richards, Andy Aldrin

Focus: Lunar payloads, resource exploration, Google Lunar X Prize.

Cost: Initial cost ~$3M/kg

Major Partnerships: NASA innovative Lunar Demonstration Data (ILDD) program ($30M); Dynetics





Examples of NewSpace Companies

DEEP SPACE

DEEP SPACE INDUSTRIES

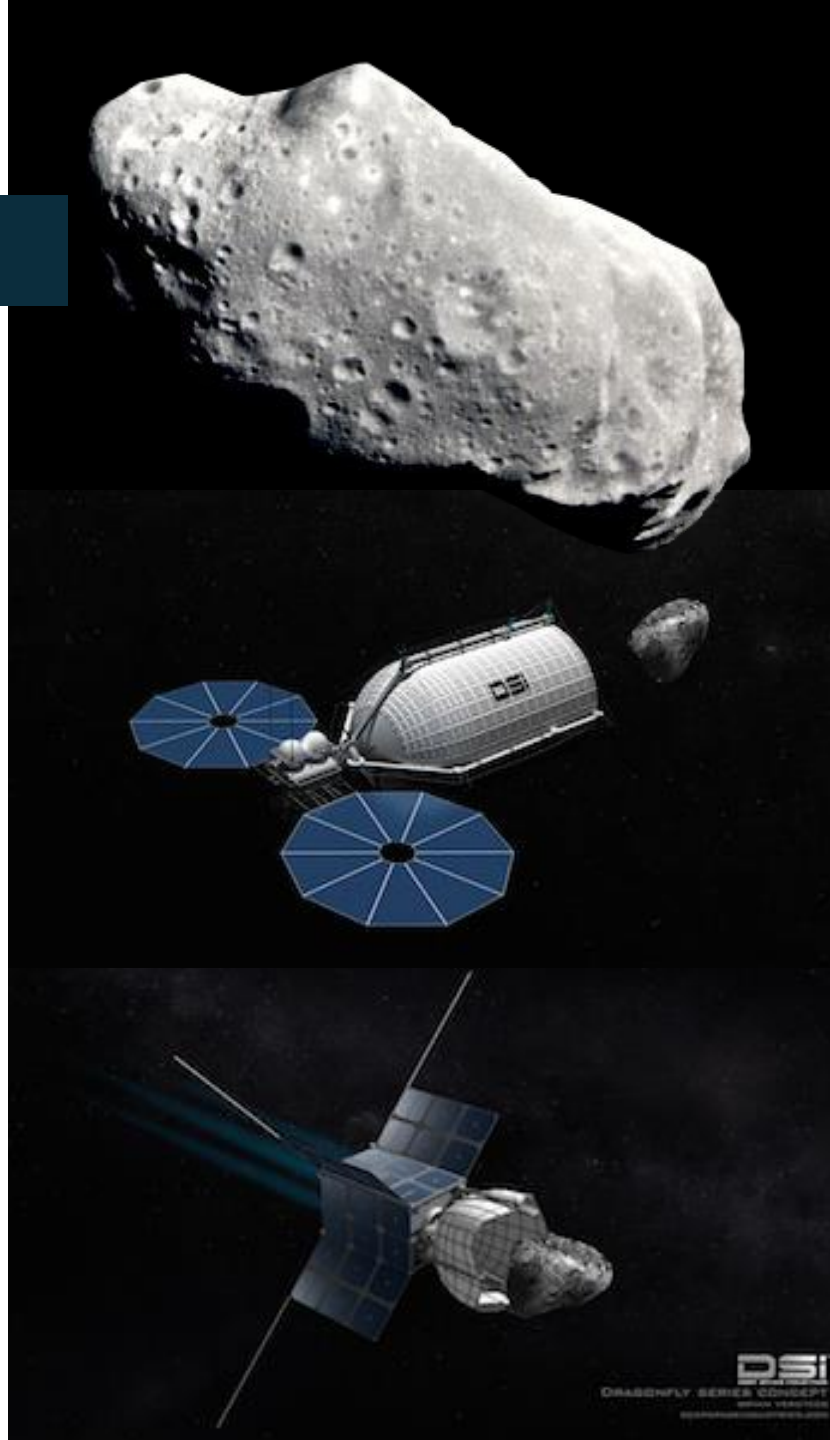
HQ: Mountain View, CA

Founded: 2013, Rick N. Tumlinson, Daniel Faber, David Gump et al.

Focus: Asteroid Mining: Water & Rare Metals

Implementation: Prospector X – tech demo, Prospector 1 – mining demo

Major Partnerships: Luxembourg, NASA Asteroid Redirect Mission



The Government's Role in Commercializing Space

Key question:

"What role should the government play in the commercialization of space?"

NATIONAL ADVISORY COUNCIL FOR AERONAUTICS (NACA)

- Established in 1915 by Congress
- Developed key technologies to **enabled air travel** to become effective, economical and safe
- Studied the problems of flight to **identify and resolve risks** that kept air travel from being **safe and commercially viable**
- Government **worked closely with industry** to fund studies that retired technological risks and **enabled private enterprise** to successfully create a new industry

CHANGES AT NASA

Program Characteristic	Early Space Age Approach	Commercial-Oriented Approach
Owner	NASA	Industry
Contract Fee-Type	Cost Plus	Fixed Price
Contract Management	Prime Contractor	Public-Private Partnership
Customer(s)	NASA	Government and Non-government
Funding for Capability Demonstration	NASA procures capability	NASA provides investment via milestone payments
NASA's Role in Capability Development	NASA defines "what" and "how"	NASA defines "what" Industry defines "how"
Requirements Definition	NASA defines detailed requirements	NASA defines top-level capabilities needed
Cost Structure	NASA incurs total cost	NASA and Industry share cost

US NATIONAL POLICY ON COMMERCIAL SPACE

"Develop a robust and **competitive U.S. commercial space sector**"

&

"**Energize competitive domestic industries** to participate in global markets"

– NASA Act (as amended June 28, 2010)

US NATIONAL POLICY ON COMMERCIAL SPACE

NASA is to achieve this by:

- Purchasing and using **commercial space capabilities** and services to the maximum practical extent
- Actively exploring the use of **inventive, nontraditional arrangements** for acquiring commercial space goods and services
- **Refraining from** conducting U.S. Government space **activities that preclude, discourage, or compete with U.S. commercial space activities**
- Pursuing potential opportunities for **transferring routine, operational space functions to the commercial space sector** where beneficial and cost-effective.

June 28, 2010

FAA Office of Commercial Space Transportation

Founded 1984, to:

- **Regulate** the commercial space transportation industry, **only to the extent necessary**
- **Encourage, facilitate, and promote commercial space** launches by the private sector
- **Recommend appropriate changes** in Federal statutes, treaties, regulations, policies, plans, and procedures:
- Facilitate the strengthening and **expansion of the U.S. space transportation infrastructure**

WHY COMMERCIAL?

- **Why Commercial?**
  - Commercial companies must be competitive and governments have other priorities (safety, jobs, etc.)
  - Example: comparison of SpaceX to NASA Development Costs
    - NASA initial estimates using its normal cost estimating software for Falcon 9 were 10 times more expensive than SpaceX actuals
    - Even when NASA made adjustments its estimates were still 4 times more
- **Conflicting goals**
  - US Congress focused on jobs in their districts

NASA PROGRAMS TO STIMULATE COMMERICAL SPACE

- **Commercial Orbital Transportation Services (COTs) 2006**
  - NASA investment $800M produced 2 new launchers 2 new ISS cargo carriers
- **Commercial Crew Development (CCDev) 2009 – 2011**
  - Stimulate development of privately operated crew vehicles
- **Commercial Crew Integrated Capability (CCiCap) 2012 – 2014**
  - Advance multiple integrated crew transportation systems to LEO
- **Commercial Resupply Services (CRS-1) 2008 - present**
  - 20 missions for SpaceX and 10 missions for Orbital Sciences
- **Commercial Resupply Services (CRS-2) 2019 - 2024**
  - 6 missions each for SpaceX, Orbital Sciences and Sierra Nevada Corporation
- **Collaborations for Commercial Space Capabilities – SAAs**
  - Advance private sector development of emerging products and services commercially available to government and non-government customers
- **Flight Opportunities Program 2010 – present; Suborbital**
  - Commercial Reusable Suborbital Research Program (CRuSR) – supports commercial suborbital spaceflight by providing a steady, guaranteed market for research payloads
  - Facilitated Access to Space Technology (FAST) – funding microgravity research

ALTERNATIVES TO GOVERNMENT FUNDING

Google Lunar X-Prize (GLXP) 2007 - 2016

- Eighteen teams currently in competition for $30M in prizes
- Land a robot on the Moon then travel more than 500m and transmits high definition images and video to Earth

NASA Innovative Lunar Demonstration Data

- Indefinite delivery/indefinite quantity (IDIQ) contracts totaling up to $30.1M

Crowdfunding

- Kickstarter: Lunar Space Elevator (Liftport Group), CubeSat Ambipolar Thruster (CAT) (UMich), Arkyd Telescope $1.5M (Planetary Resources) etc.
  - Spire

NEWSPACE INVESTMENTS (NSG 50)

$200M-$2B

SpaceX
Virgin Galactic*
Blue Origin*
Vulcan Aerospace*
O3B
OneWeb
Planet Labs
Cloudera

$20M-$200M

Skybox
Spaceflight Industries
MapBox
Spire
Moon Express
SpaceIL
Kymeta

$2M-$20M

Dauria Aerospace
Planetary Resources
OmniEarth
Satelogic
Astroscale
Nanoracks
XCOR
Rocket Lab
Firefly
Reaction Engines
Accion Systems
Orbital Insight
ClearStory Data
SpaceKnow

Crunchbase Data 2015

(*) SVSC estimates

Source: Sean Casey (SVSC)

From 2005-2015 $12B in private investment Source: Silicon Valley Space Center

NEWSPACE INVESTMENTS - Luxembourg

- The Luxembourg Government announced a series of measures to position Luxembourg as a European hub in the exploration and use of space resources (February 3, 2016).

- Luxembourg will develop a legal and regulatory framework confirming certainty about the future ownership of minerals extracted in space from Near Earth Objects (NEO's) such as asteroids.

- Opening a €200 million ($225 million) line of credit for entrepreneurial space companies to set up their European headquarters within its borders (June 3, 2016).

WRAP UP

You should be able to:

1) List some examples of areas where entrepreneurial companies are developing new markets;
2) Name a few companies that are examples of the commercial space revolution;
3) Discuss how governments and private industry can facilitate the birth of this new industry; and

ORGANIZATIONS PROMOTING NEWSPACE

Students for the Exploration and Development of Space (SEDS)

1980 founded by the same 3 founders as ISU, to promote space exploration and development.

National Space Society

1987 promotes living in and working in space. The organization is located in many countries.

Space Frontier Foundation

1988, dedicated to free enterprise and human settlement of the Solar System

Space Access Society

1992, dedicated to reducing the cost for commercial access to space.

Commercial Spaceflight Federation

2005, promotes commercial human spaceflight, high levels of safety, and shares best practices and expertise throughout the industry.

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